The Opportunities and Challenges of Selling Hydrogen to the Industry

July 1, 2025

MESSY MIDDLE BOOTCAMP

RUN ON LESS MESSY MIDDLE

NACFE
NORTH AMERICAN COUNCIL FOR FREIGHT EFFICIENCY

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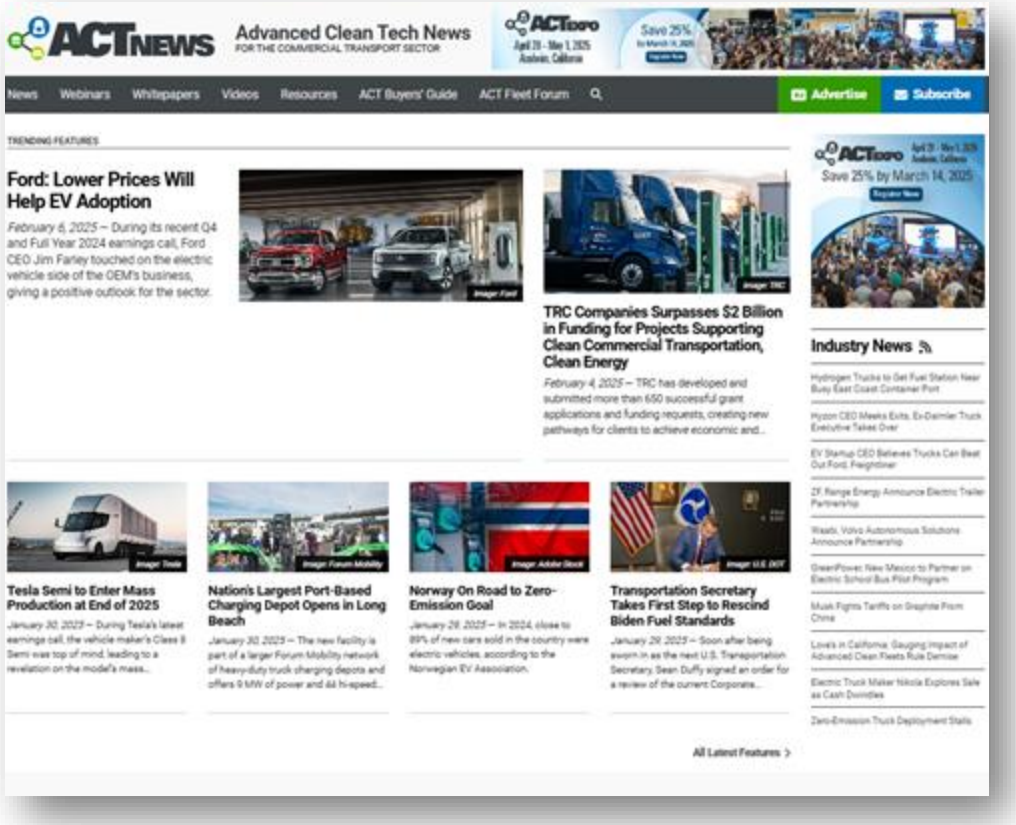
Advanced Clean Tech News For the Commercial Transport Sector



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Messy Middle Bootcamp Series

Diesel Drop-In Alternatives: Ultra-Low Sulfur, Bio-, and Renewable (February 11th) ✓

Decarbonizing with Natural Gas (February 25th) ✓

Future Prices & Availability of Existing Infrastructure: What's Next? (March 11th) ✓

DIESEL AND NATURAL GAS WORKSHOP (March 25th) ✓

The Current State of HD BEV: Technologies and Capabilities (April 8th) ✓

Strategizing Successful HD BEV Adoption (April 27th) ✓

Charging Depots, Networks & the Economics of Fleet (May 6th) ✓

HD BEV WORKSHOP (May 20th) ✓

The Production Processes of Hydrogen Fuel (June 3rd) ✓

Moving Hydrogen from Here to There: The Distribution and Storage of Hydrogen Fuel (June 17th) ✓

The Opportunities and Challenges of Selling Hydrogen to the Industry (July 1st)

HYDROGEN FUEL CELL WORKSHOP (July 15th)

2023 Bootcamp is still available at: https://runonless.com/electric-depot/

Update from the Run...

Follow the Fleets, Drivers, providers, and more on:

RunOnLess.com and on Twitter @RunOnLess

RUN ON LESS MESSY MIDDLE

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Today's Bootcamp Sponsor

HydroFleet

POWER TO MAKE A DIFFERENCE

RUN ON LESS MESSY MIDDLE

MESSY MIDDLE BOOTCAMP

Quiz for Today's Session

Completing Today's Quiz:

- Go to runonless.com and click back into the session
- Click 'Take Quiz' button
- Create username and password to keep track of your progress
- Provide your name and email to enter a drawing for a Run on Less - Messy Middle swag bag

What You Should Know

Q&A

Submit your questions to the host using the Q&A box in the upper right-hand corner

Recording

A recording of today's webinar will be available on runonless.com

Technical Issues

Contact Stephane Babcock at

sbabcock@trccompanies.com

Today's Bootcamp Speakers

The Opportunities and Challenges of Selling Hydrogen to the Industry

Tarek Abdel-Baset
Director of Business Development for Hydrogen Storage Systems
FORVIA

Ben Happek
General Manager, Commercial Vehicles & Hydrogen
Hyundai Motor America

Derek Rotz
Director in Advanced Engineering
Daimler Truck North America

Hui Xu
Technical Project Leader Global H2 ICE
Cummins

RUN ON LESS MESSY MIDDLE

MESSY MIDDLE BOOTCAMP

RUN ON LESS BY NACFE

HYDROGEN STORAGE – FOR MOBILITY MESSY MIDDLE BOOT CAMP

TAREK ABDEL-BASET

JULY 1ST 2025

FORVIA faurecia

FORVIA: A GLOBAL AUTOMOTIVE TECHNOLOGY SUPPLIER

6
Business Groups

€27bn
sales

1 in 2
vehicles worldwide equipped with FORVIA products

€31bn
order intake

150,000
employees

15,000
R&D engineers

Ambition to become
#1 worldwide in **Hydrogen solutions**

A turnover multiplied by
10 since 2020

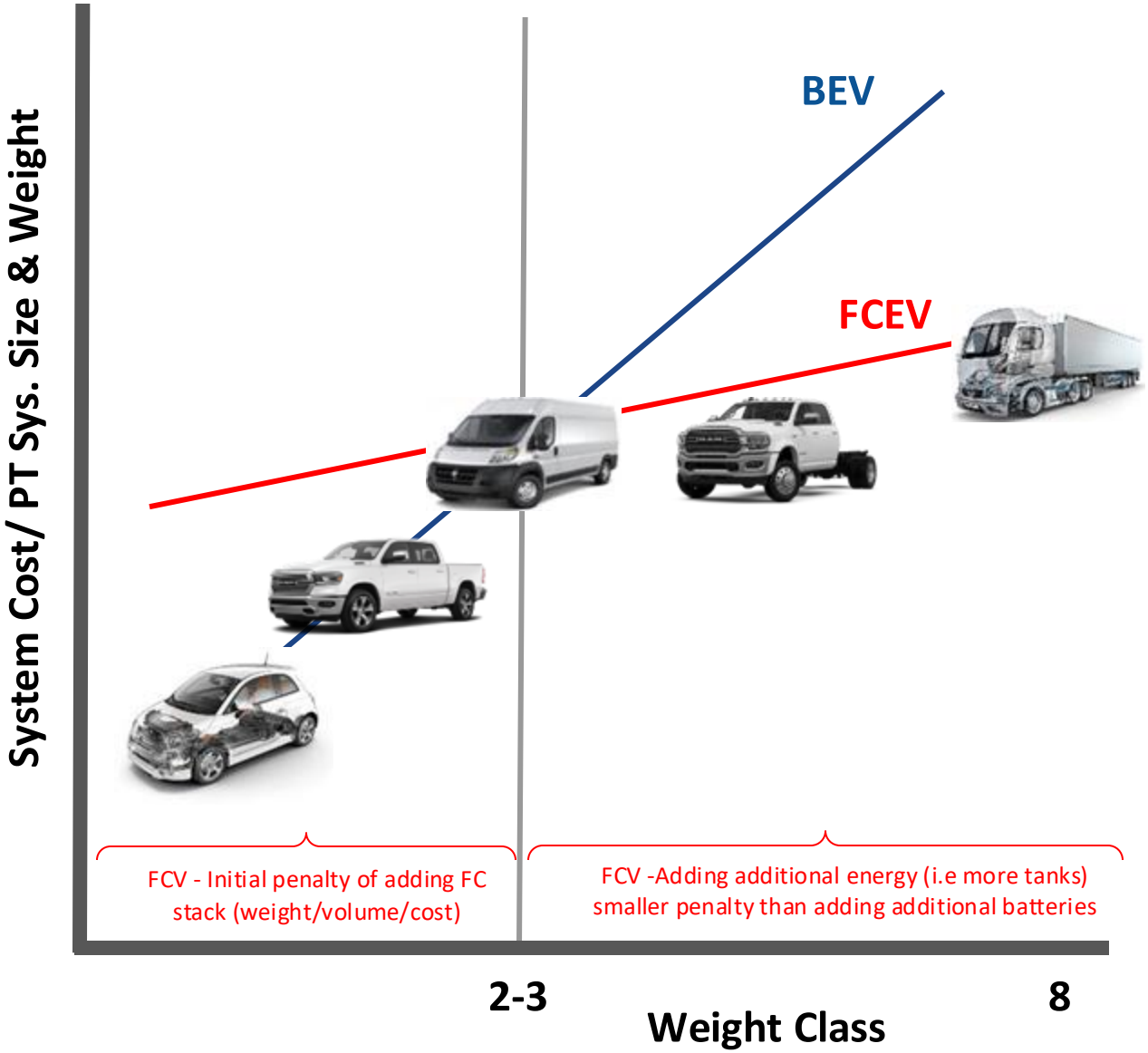
40% **CAGR** since 2022

Symbio
FORVIA, Stellantis and Michelin company

All figures as of December 31, 2024

FORVIA
Inspiring mobility

Why Fuel Cell Vehicles? The Crossover Point



FCV Benefits vs BEV

As vehicle energy requirement increases, FCV potential advantages include;

- **Lower System Cost**
  - For same kWh
  - Assuming high volumes (500k/yr)
- **Increased Payload Capacity**
  - Lower system weight (kW/kg) for same kWh
- **Faster Charge time (<10mins)**

TCO advantage with vehicles with high uptime duty cycles

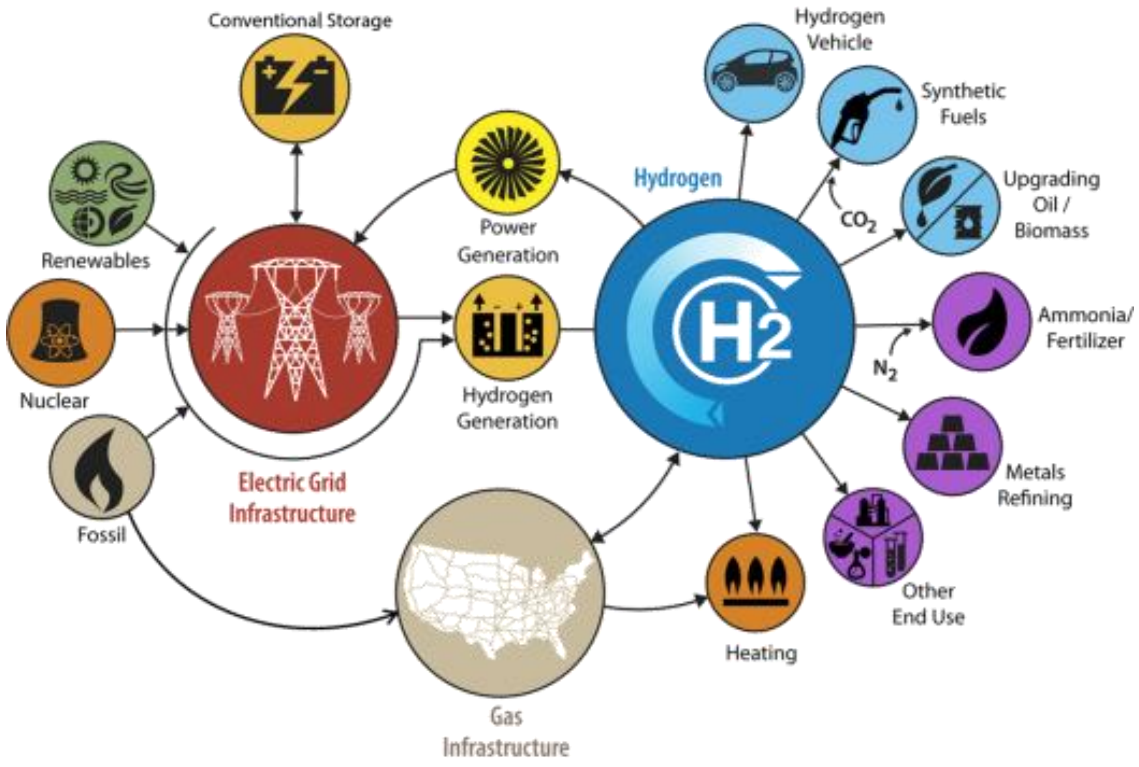
- **Increased Range**
  - Higher volumetric energy (kWh/l)
- **Improved packaging**
  - Lower System Volume for same kWh
- **Potentially Lower Infrastructure Costs**
  - Highly dependent on local grid constraints and fleet size

PORVIA faurecia

Why Hydrogen?

1. **H_2 is an excellent *Energy Buffer* for high power &/or energy demands :**
   - Transportation, building feedstock, grid balancing etc.
   - Increased renewable energy production requires increased energy buffer in grids
   - Alternative to Electricity / Grid in difficult to decarbonize industries (Steel, Fertilizer Industrial heating etc)
   - Can account ~20% penetration into the energy grid

1. **Multiple Pathways for H_2 Production and Delivery**
   - Provides regional specific energy security flexibility/ solutions
   - Lower cost infrastructure solution vs new electrical grid installations in many scenarios



https://www.energy.gov/sites/prod/files/2019/09/f67/fcto-h2-at-scale-handout-2019.pdf

FORVIA faurecia

DIFFERENT TYPES OF HYDROGEN STORAGE

Many Different Ways to Store Hydrogen

- All have significant challenges in at least one key metric

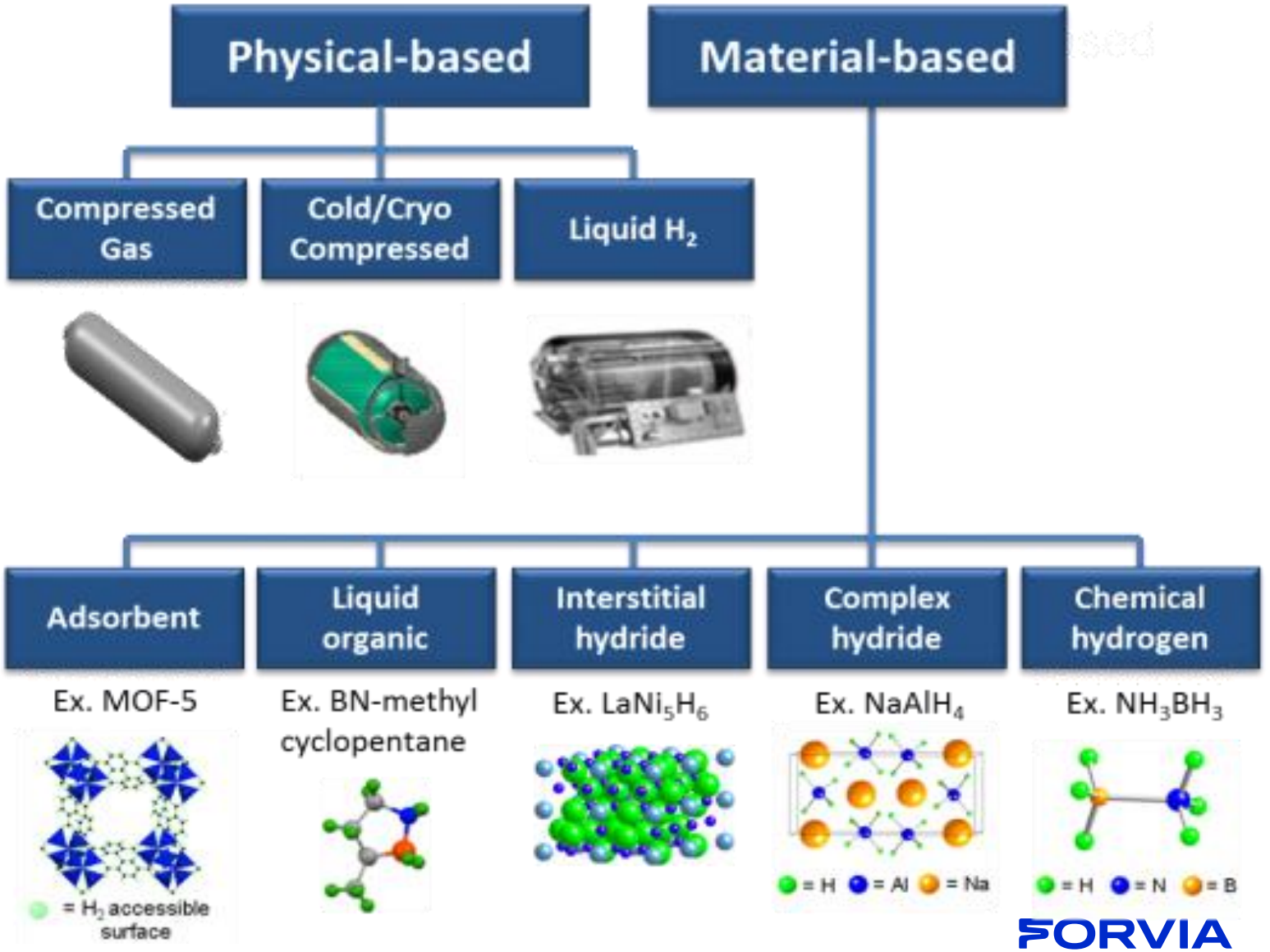
Physical based systems

- Contain hydrogen in "*Diatomic* (H-H)" form as Gas or liquid - various pressures and temperatures

Materials Based Systems

- Store hydrogen in *"Monatomic H^++ H^+"* Form

Hydrogen is split and bound to other materials via weak or strong forces



FORVIA faurecia

HYDROGEN STORAGE - PHYSICAL STORAGE

Internal & Partners

Compressed Gas

Most OEMs launching on 700 bar (10,000 psi) systems "Type 4" tanks

- Carbon fiber outer wrapping + plastic inner liner
- 4-6 kgs of H_2 for 300- 350 miles on midsize vehicle

- Simplest of storage system options
- Fast filling
- Durable
- Safer than you think!

- Expensive (60% carbon fiber cost)
  - ~$1000/kg today's tech & volumes
- Lowest energy density option
- Energy of compression significant efficiency loss in well to wheel pathway (upto 10-20% of energy value of H2)

Liquid

- 2-3X system energy density of compressed gas 700 bar
- Very cold temps required 20K to keep in liquid state
- Significant insulation required

- Self "purifying fuel" by default achieves fuel purity requirements for FCs
- Low Pressure < 60 psi

- Evaporation "Boil Off" = loss of fuel
  - Typically 1-2% per day
- Vehicle needs to be used daily to prevent boil off
- Energy of liquefaction worse than compressed (upto 20-30% of energy value of H_2)

Cryo Compressed

- 3-4X system energy density of compressed gas 700 bar
- Combination of pressure and low temperature

- Highest energy Density
- Self "purifying fuel" by default achieves fuel purity requirements for FCs

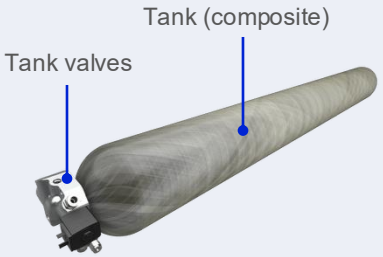
- System cost and compression/ liquefaction energy in between compressed & liquid
- Boil Off" still occurs but significantly delayed (20-40 days)
- Complicated system and infrastructure
- Inconsistent fill levels- dependent on how hot tank is at beginning of fill

FORVIA faurecia

MODULAR & SCALABLE OFFER
UP TO COMPLETE STORAGE SYSTEMS

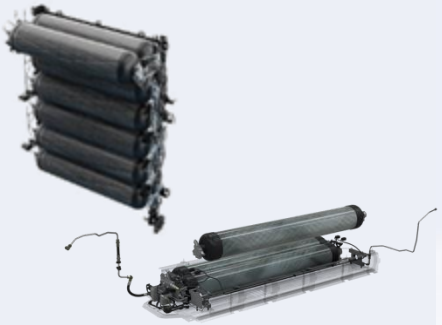
MOBILITY

Tank equipped with valves



Storage system delivered in kit

Plug & play module

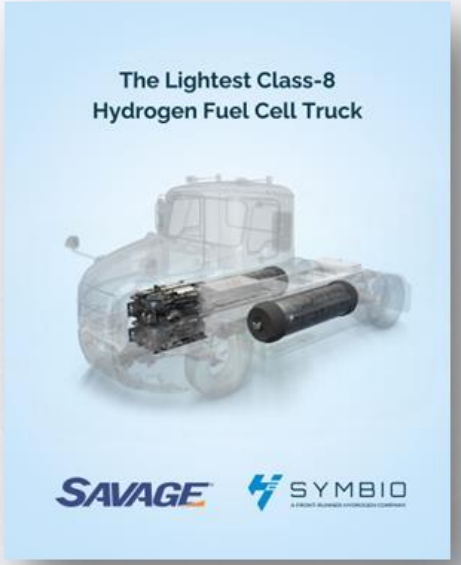


FORVIA
Inspiring mobility

FORVIA PARTNERSHIPS ACROSS MOBILITY DISTRIBUTION AND VALUE CHAIN

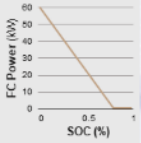
HYDROGEN ENGINE ALLIANCE

SwRI SOUTHWEST RESEARCH INSTITUTE



FORVIA

SYMBIO

	Hydrogen Storage System (HSS)			Fuel Cell Stack System				Other components	
Total Value	40%			35%				25%	
									
	Fuel cell tank	Valve	Auxiliaries & pipings	Bipolar Plates	Membrane electrode assembly	Endplate + other components	Interfaces & controls laws	Electric & electronics	Cooling, air compressor,…

BayoTech

FORVIA IS ENGAGED ON 75% OF THE H2 drivetrain

FORVIA
Inspiring mobility

THANKYOU

RUN ON LESS BY NACFE

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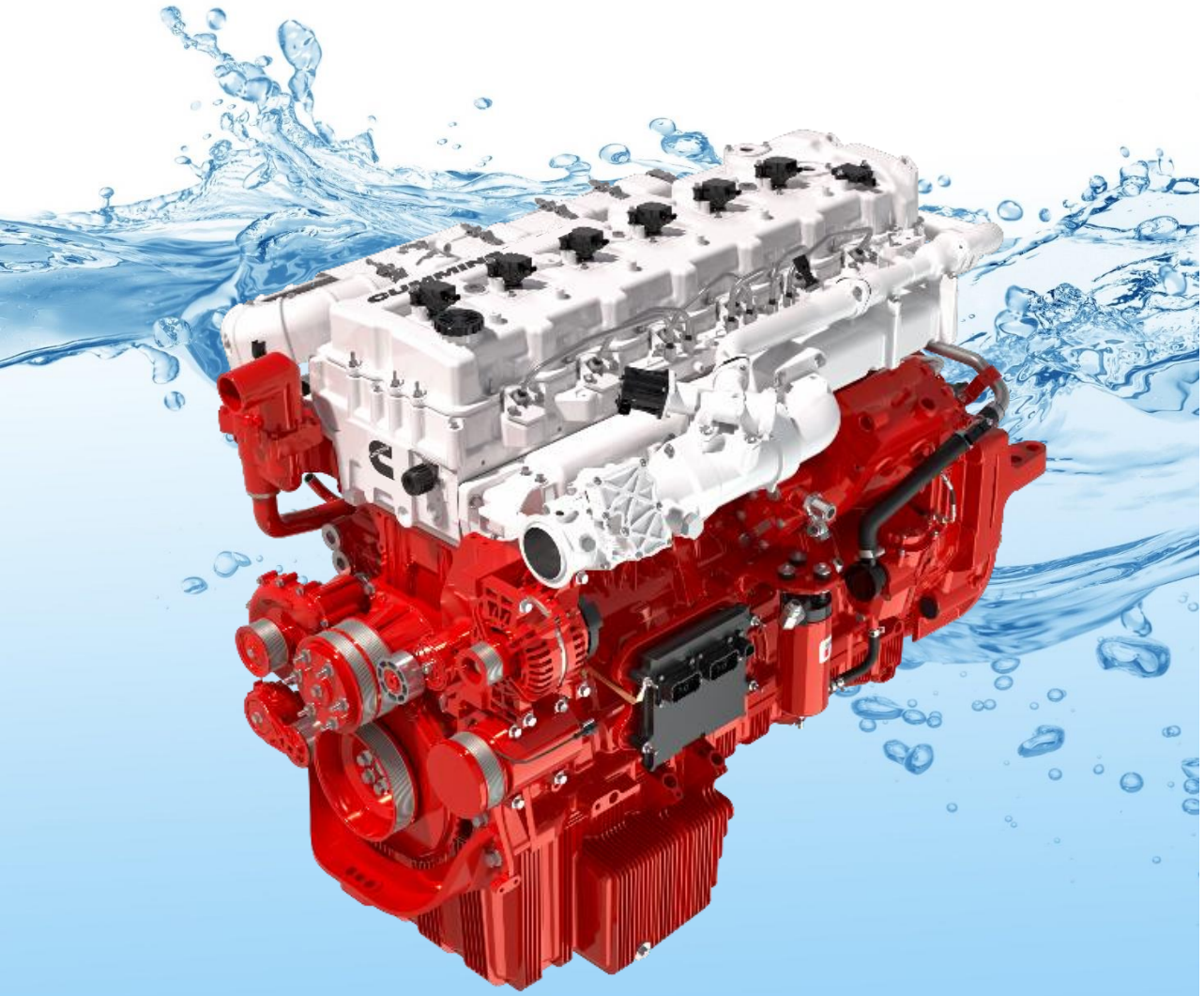


Cummins Hydrogen Internal Combustion Engine (H2-ICE)

Hui Xu
Imon Uduehi

July 01 2025

Destination Zero, powered by Cummins

Climate change is an existential crisis. Our world will forever need power. We've made finding solutions to these twin challenges our responsibility. Destination Zero is the road we've paved to a zero emissions future where we continue to provide the power that our world needs.

Different Use Cases: Complementary Technologies

Diesel

Versatile
Reliable
Low Cost
Ubiquitous

Use Case
Regulations
Incentives
ESG
Infrastructure
Business Model
…

Zero CO_2 Technologies

- H2 Fuel Cell
- H2 Internal Combustion Engine (ICE)
- Renewable Natural Gas
- Renewable Diesel

- Battery Electric Vehicles

	Urban	Regional	Long Haul
Daily Mileage (miles)		200	400
Daily Usage (hours)		Up to 4	Up to 6


Regional Haul


Line Haul


Vocational


Construction


Agriculture


Terminal Tractor


Power Generation

…AND MORE

Cummins Internal Use

Cummins

H_2 ICE – A Complementary Solution

- Spark ignited engine variant, similar to Natural Gas/Gasoline engine hardware
- Utilises existing installed capacity in engine and components manufacturing
- Extends life of internal combustion engine, complimentary with fuel cell.

Diesel	Hydrogen	Natural Gas/Gasoline
Base engine (block, crank, auxiliaries, etc)		
Installation parts (mounts, flywheel housings, REPTO, pipework, etc)		
	Cylinder head (DOHC, VVA etc.)	
	Ignition system	
	Engine control unit, and software	
	Fuel system	
	Air handling system	
Aftertreatment system – NH3-SCR		

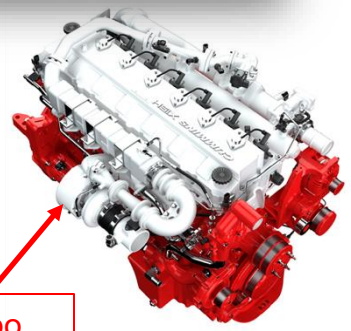
H_2- Fuel Cell	H2-ICE
H_2 production	
H_2 distribution	
H_2 filling station availability	
On-board H_2 storage	
Needs electrification of driveline & accessories	Uses existing drivelines & accessories
No aftertreatment	Requires aftertreatment

Cummins Internal Use

H_2 ICE Architecture Considerations

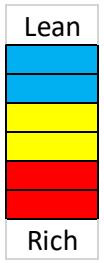
Common between MD and HD

Base engine: pent roof tumble system



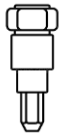
Turbo

- Turbo needs to deliver the air flow and transient response



Air fuel ratio

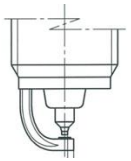
Lean burn offers better power density and efficiency than stoic.



Fuel system

H_2 DI (Direct Injection) reduces IMOP risk and offers power density advantage

H_2 ICE ECU and software is progressed from existing system.

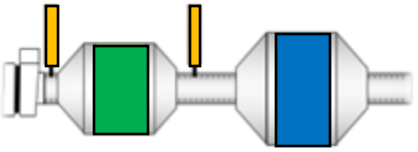


Ignition system

Cold spark plug reduces pre-ignition and knock propensity, meet spark plug life expectation.

Crankcase H_2 and moisture

PCV (Positive Crankcase Ventilation), low blowby piston rings



Aftertreatment

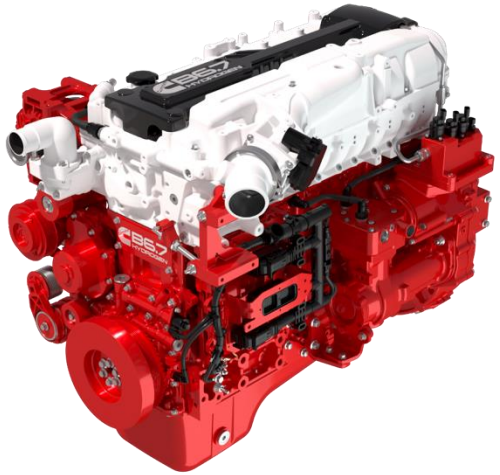
- **Urea SCR** (Selective Catalytic Reduction) will be used to ensure the emissions compliance as the minimum requirement.

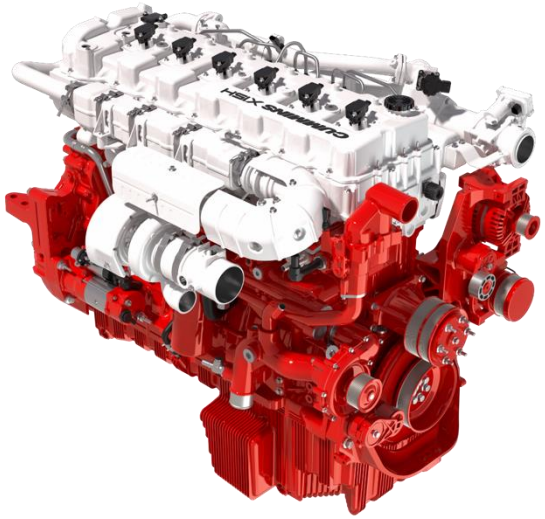
Valve profile and phaser

- Balance the air flow and effective compression ratio

Cummins Internal Use

Cummins Hydrogen Engines

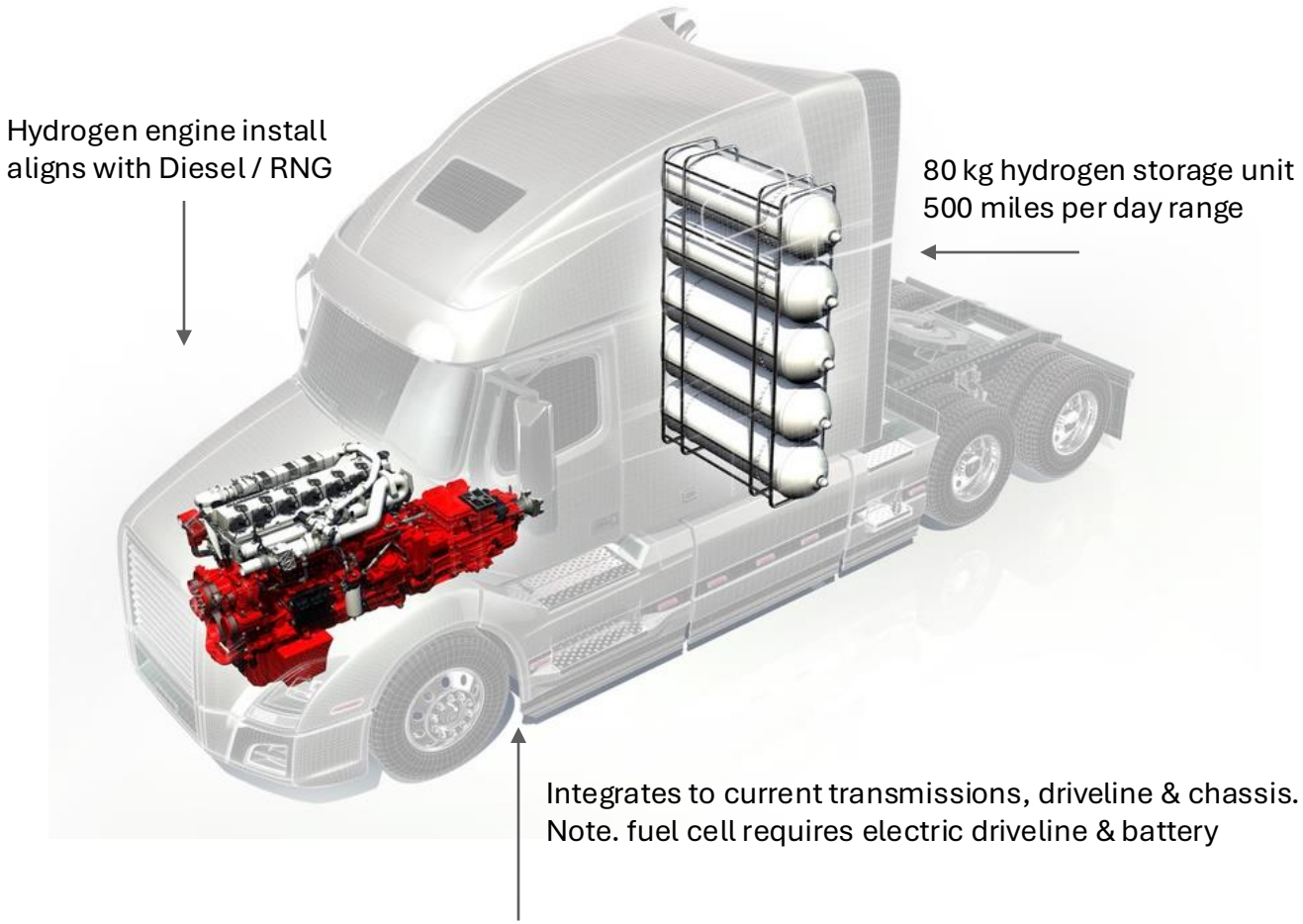




Engine	*B6.7H*	*X15H*
Displacement	6.7L	16L
Power	170 – 215 kW 230 – 290 hp	300 – 400 kW 400 – 530 hp
Torque	900 – 1100 Nm 650 – 810 ft lb	2100 – 2600 Nm 1550 – 1900 ft lb
Emission Level	Euro VII | China NS VII | EPA 2027 | Stage V | T4F	
Architecture	Pent Roof Cylinder Head, Tumble Combustion, Spark Ignited, Direct Inject, Lean Burn, SCR Aftertreatment	

Cummins Internal Use

Hydrogen ICE: Example Vehicle Specs



Target End User	Large Fleet
Vehicle	Class 8 Sleeper Cab
Fuel	Hydrogen
Engine	X15H
Displacement	16-liters
Performance	450hp / 1850ft lbs
Transmission	Endurant AMT
Range	500 mi
Base Warranty	2 Year / Unlimited Miles
Durability	Same as diesel
Vehicle Weight	2,500 lbs* more than diesel

* Anticipated 2,000 lbs GVWR low carbon technology allowance from DOT. Cummins is working with the DOT to increase the allowance by 500 lbs.

Cummins Internal Use

More Information

www.cummins.com/engines/hydrogen

Contact Information

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Hui Xu
Hydrogen Engine - Technical Project Leader
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Cummins Internal Use


Cummins

Hyundai XCIENT Fuel Cell Class 8 Truck Introduction

Run on Less – Messy Middle Bootcamp #9

Dr. Benjamin Happek, General Manager, Energy & Hydrogen, HMNA

HYUNDAI MEETS HYDROGEN TECHNOLOGY

26 years of R&D activities on fuel cell technology with the most diverse line-up of FCEVs

1998
Initiated FC development

2000
Prototype

2013
The world's 1st mass produced FCEV

2018
World's best-selling FCEV

2020
The world's 1st mass produced FC truck

2020
Mass produced FC bus for city transportation

2022
High-performance concept FCEV

2023
FC coach bus for long-haul

Long-haul tractor optimized for NA

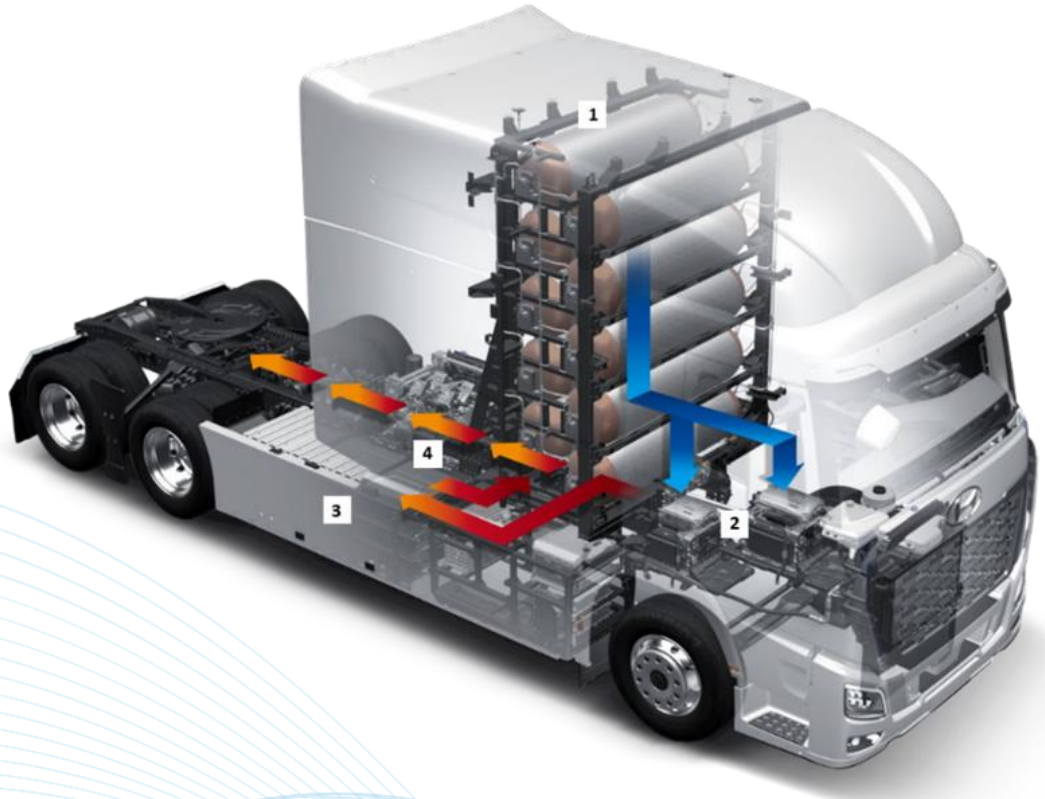
FIRST DEPLOYMENTS IN EUROPE SINCE 2020

- 49 trucks on the road
- More than 8.3 million mi in customer operation
- Technology works and is reliable
- FC system lasting longer than expected / calculated with

- Positive customer feedback:
  - ✓ Low noise & vibration
  - ✓ No breakdowns or quality issues
  - ✓ Excellent cold-weather performance

XCIENT FUEL CELL 6X4 TRACTOR

US



Max. power output
350kW

Fuel Cell systems
2x90kW

Battery
72kWh

Hydrogen capacity
68Kg/700bar

Target Range
Over 450miles

Refueling Time
Around 30min.

HIGH-TECH HYDROGEN SYSTEM

HYDROGEN TANK 1
68.6 kg H2 (700 bar)

STACK 2
180 kW (2 x 90 kW each)

BATTERY 3
72 kWh (3 x 24 kWh each)

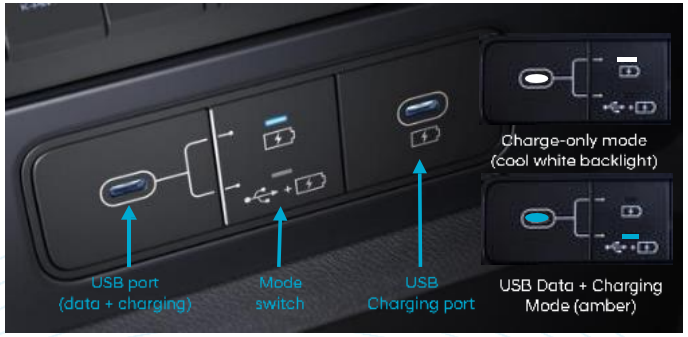
MOTOR 4
350 kW / 1,650 lbf·ft

XCIENT FUEL CELL 2025 MY ENHANCEMENTS

Thoughtful new features and technologies to assist the driver

Wider command center

Everything you need to know without interrupting everything you need to see: the enlarged 12.3-inch cluster delivers all the essential information through sharp, easy-to-read graphics.



Switch-type USB module

It supports fast charging via a C-type USB port up to 27 W, features a simple switch to change modes, and offers two charging ports.

Revised front pillars (BCW indicator installed)

The BCW & BCW_Near indicators are mounted on both front pillars for high visibility.

Intuitive 12.3-inch touchscreen

AVN features physical buttons for optimal operability.
It provides infotainment and seamlessly connects to your mobile device.

HVAC controller

The HVAC control center is accessible through a new LCD.

* HVAC: Heating, Ventilation, and Air Conditioning

Trailer air supply and parking brake switches

Switches within easy reach.

NorCal Zero
California

HMGMA Plant
Georgia

Hyundai
Plant
Alabama

KIA
Plant
Georgia

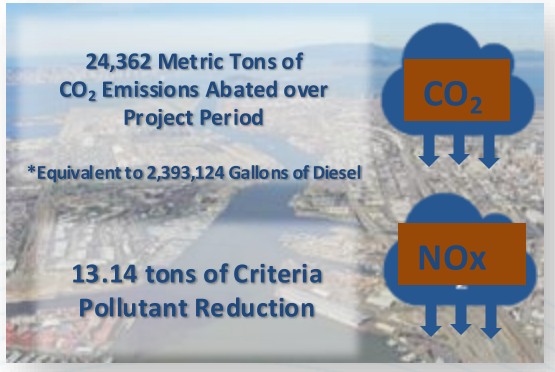
NORCAL ZERO PROJECT

Zero-Emission Regional and Drayage Operations

H_2 Refueling Station

- Largest HD HRS in the World Capable of Filling 200 Class 8 Trucks per Day with Hydrogen
- 20-minute Fill Time to Enable 430+ Miles of Range

Community Impact



- Improving Air Quality of Disadvantaged Communities Around the Port of Oakland
- Strong Community Engagement via the West Oakland Environmental Indicators Project (WOEIP)

H_2 Truck Deployment

CARB Chairwoman Liane M. Randolph with WOEIP Executive Director Brian Beveridge

- ***Largest Single Deployment of HD Trucks in the World: 30 Hyundai XCIENT Fuel Cell Tractors at the Port of Oakland***
- 10 service technicians and 30+ operators trained
- Fleet Operator GET Freight is Serving 7 Customers Within a 150 mi Radius


HYUNDAI
HTWO
LOGISTICS
HYUNDAI MOTOR GROUP
HYUNDAI
GLOVIS

Construction underway for the industry's first high-volume Class-8 hydrogen refueling station in the U.S.

In collaboration with HTWO Logistics, HydroFleet's $28M Pooler, GA Hydrogen Facility opens Q3 2025.

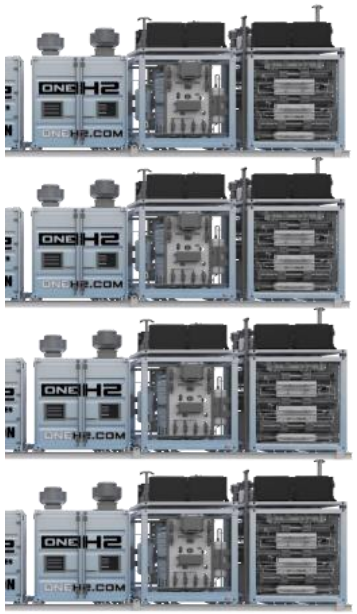
- $28M+ invested in direct infrastructure to produce hydrogen fuel onsite.
- Facility will produce, store, and dispense hydrogen fuel for class 8 hydrogen heavy truck fleets & more.
- Location will feature "retail fueling station" design.
- Ability to supply and transport H2 fuel to regional hydrogen fleets with Port of Savannah and nearby railway.
- Existing demand already driving expansion of production output.

POOLER, GA – HYDROGEN PRODUCTION CAPACITY	
Initial H2 fuel production	1,200 kg daily
Future H2 fuel production	4,200 kg daily
Onsite hydrogen fuel storage	5,000 kg

All renderings shown are for illustration purposes only.

HTWO LOGISTICS
HYUNDAI MOTOR GROUP

High-Capacity Distribution Model



Bulk trailer

Transload

HRS

>700kg day

600 mi

Hydrogen Hub
Many H600s
Low feedstock $
Low O&M
Low carbon options

Bulk Distribution
T1200 Trailers
1200 kg per delivery

Point of use
D700.S HRS

THANK YOU

HYUNDAI

SUPERTRUCK

Derek Rotz

DAIMLER TRUCK
North America

SuperTruck III Outlook

DAIMLER TRUCK
North America

DEMONSTRATE 2 Class 8 long-haul vehicles

RANGE of 600 miles without compromising payload or wheelbase

CELLCENTRIC fuel-cell system with power and high-voltage battery

FIRST PROTOTYPE (gaseous hydrogen) in 2025, final demonstrator (subcooled liquid hydrogen) in 2027

100 kg in LIQUID HYDROGEN, refueling time on par with Diesel

AMBITION Demonstrate the full potential of hydrogen

2 Vehicle Strategy

DAIMLER TRUCK
North America

B-Sample	
• Cab	= 126” BBC, 72” Sleeper
• Chassis	= 255” w/b Diesel based tractor
• Tires / eAxle	= 315 tires / 6x2
• Fuel Cell System	= Fuel Cell System behind cab
• H_2 Tank Capacity	= 700 Bar 30 kg CHG saddle tanks
• Battery Capacity	= 200 kWhr Battery
• Cooling System	> 300 kW heat rejection
• Intent	= First Functionality

Final Demonstrator	
• Cab	= 126” BBC, 72” Sleeper
• Chassis	= **223”** w/b Diesel based tractor
• Tires / eAxle	= 315 Tires / new **6x4 eAxle**
• Fuel Cell System	= **NextGen fuel cell underhood**
• H_2 Tank Capacity	= **100 kg using sLH2**
• Battery Capacity	< **100 kWhr Power battery**
• Cooling System	> 300 kW heat rejection
• Intent	= **Fleet feedback optimized**

B-sample learnings drives final demonstrator design

Any proposed future work is subject to change based on funding levels.

Q&A

The Opportunities and Challenges of Selling Hydrogen to the Industry

Tarek Abdel-Baset
Director of Business Development for Hydrogen Storage Systems
FORVIA

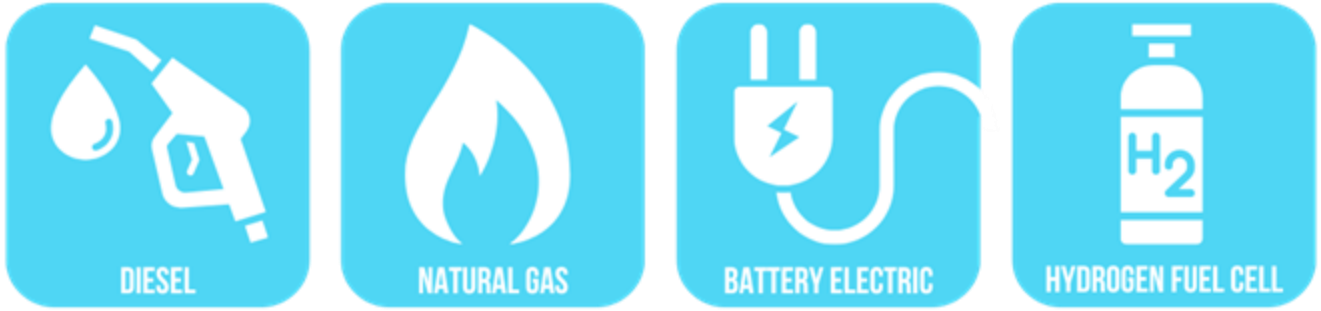
Ben Happek
General Manager, Commercial Vehicles & Hydrogen
Hyundai Motor America

Derek Rotz
Director in Advanced Engineering
Daimler Truck North America

Hui Xu
Technical Project Leader Global H2 ICE
Cummins

RUN ON LESS MESSY MIDDLE

MESSY MIDDLE BOOTCAMP



Let's Stay Connected…

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